Technical training.
Product information.

F30 Powertrain

Edited for the U.S. market by:
BMW Group University
Technical Training
ST1113 6/1/2012

BMW Service

General information

Symbols used

The following symbol is used in this document to facilitate better comprehension or to draw attention to very important information:

Contains important safety information and information that needs to be observed strictly in order to guarantee the smooth operation of the system.

Information status and national-market versions

BMW Group vehicles meet the requirements of the highest safety and quality standards. Changes in requirements for environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, there may be discrepancies between the contents of this document and the vehicles available in the training course.

This document basically relates to the European version of left-hand drive vehicles. Some operating elements or components are arranged differently in right-hand drive vehicles than shown in the graphics in this document. Further differences may arise as a result of the equipment specification in specific markets or countries.

Additional sources of information

Further information on the individual topics can be found in the following:

- Owner's Handbook
- Integrated Service Technical Application.

Contact: conceptinfo@bmw.de

The information contained in this document forms an integral part of the technical training of the BMW Group and is intended for the trainer and participants in the seminar. Refer to the latest relevant information systems of the BMW Group for any changes/additions to the technical data.

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F30 Powertrain

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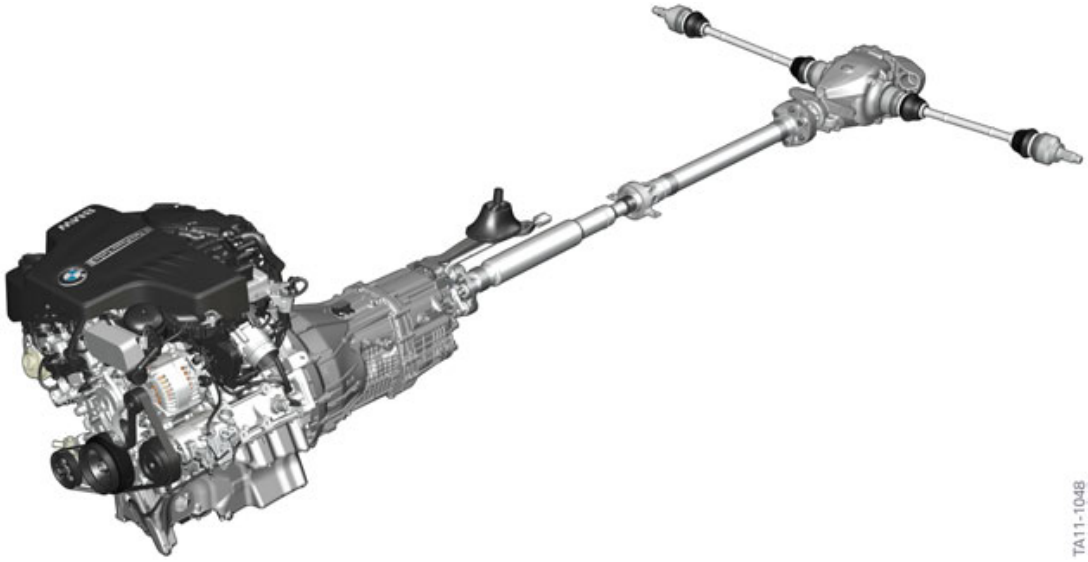
1. Powertrain Variants



F30 powertrain

1.1. Models

The F30 will be launched onto the market in February 2012 in the following models:

- BMW 328i
- BMW 335i

1.1.1. Gasoline engines

		BMW 328i	BMW 335i
Engine		N20B20O0	N55B30M0
Power output	[kW (HP)]	180 (240)	225 (300)
Torque	[Nm (ft lbs)]	350 (255)	407 (300)
Automatic transmission		GA8HP45Z	GA8HP45Z
Manual gearbox		GS6-17BG	GS6-45BZ
Rear axle differential		HAG 188LW	HAG 215LW[1] HAG 188LW[2]

[1] with manual gearbox.

[2] with automatic transmission.

F30 Powertrain

2. Engines

2.1. N20 Engine

The N20 engine is the new generation of the 4-cylinder gasoline engines at BMW and was installed for the first time in the E84. It is gradually replacing both the 4-cylinder engines N46 and N43, as well as the 6-cylinder naturally aspirated engines N52 and N53. The latest technology has been used for the N20 engine such as Turbo-Valvetronic direct injection (TVDI) in connection with a twin-scroll exhaust turbocharger for example.

Special features

- Combination of TwinPower Turbo, direct fuel injection (DI) and Valvetronic
- Reduction of fuel consumption by 15% compared to the N52 engine
- Reduction of the engine weight by 22 kg compared to the N52 engine
- All-wheel drive capability
- Exhaust emission standards
- Global use thanks to homogeneous mixture preparation.

2.1.1. New features/changes

Engine mechanics

- Aluminium crankcase with LDS-coated cylinder barrels
  (The electric arc spraying is a powerful wire spraying for the manufacture of coatings for which electrically conducted materials are sprayed.)
- Friction-optimized crankshaft drive
- Optimized cooling jacket
- Turbo-Valvetronic direct injection (TVDI)
- Twin-scroll exhaust turbocharger
- 3rd generation Valvetronic with new intermediate levers
- New variable camshaft timing control (VANOS) with central valve
- Camshafts (all the components are shrink-fitted onto the shaft pipe)
- Two-part crankcase ventilation
- Forged crankshaft
- Crosswise crankshaft drive (offset of crankshaft axle to cylinder mid level)
- Piston with negative axial offset (offset of piston pin axle from the cylinder mid level)
- Chain drive for counterbalance shafts with chain tensioner
- Counterbalance shafts arranged on top of one another.

F30 Powertrain
2. Engines

Oil supply

- Map-controlled oil pump
- New pendulum-slide oil pump
- Raw oil cooling (engine oil/coolant heat exchanger in oil circuit before oil filter)
- New combined oil pressure and temperature sensor.

Air intake and exhaust emission systems

- Twin-scroll exhaust turbocharger
- Hot film air mass meter 7 in all engine versions
- Three connections for crankcase ventilation
- Different number of connections for tank ventilation (depending on the variant)
- Air-gap-insulated exhaust manifold, six into two
- Upstream catalytic converter.

Vacuum system

- Two-stage vacuum pump
- Vacuum reservoir for the wastegate valve permanently connected to the engine cover.

Fuel preparation/supply

- Direct fuel injection with central injector position and up to 200 bar fuel injection pressure
- Solenoid valve injectors
- Bosch high-pressure pump
- High-pressure lines to the injectors soldered to the rail
- No low fuel-pressure sensor
- Three different tank ventilation variants.

Cooling

- Electric coolant pump
- Established heat management.

Engine electrical system

- Bosch MEVD 17.2.4 engine control unit

For more information please refer to the "N20 Engine" Training Information ST1111

F30 Powertrain

2. Engines

2.1.2. Technical data

		N20B20O0 F30, 328i US version
Design		R4
Valves per cylinder		4
Engine control		MEVD 17.2.4
Displacement	[cm^3]	1997
Stroke/bore	[mm]	90.1/84.0
Power output at speed	[kW (HP)] [rpm]	180 kW (240) 5000 – 6000
Torque at speed	[Nm (ft lbs)] [rpm]	350 Nm (255) 1250 – 4800[1]
Compression ratio	[ε]	10.0 : 1
Fuel grade		RON 91 – 98
Exhaust emission standards		Ultra Low Emission Vehicle (ULEV) II
Fuel consumption (manual/automatic transmission)	[l/100 km]	---
Acceleration 0 – 100 km/h (manual/automatic transmission)	[s]	6.2/6.4

[1] for automatic transmission: 1500 – 4800 rpm

[2] values were still not available at editorial deadline.

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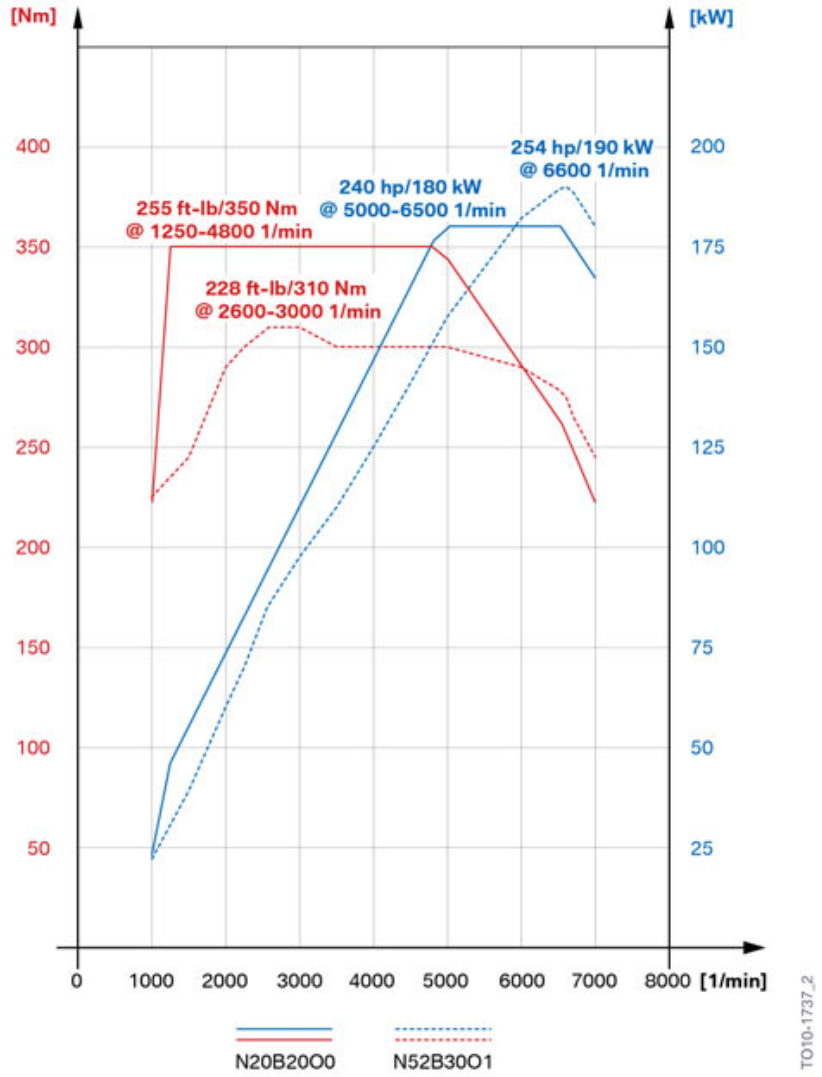
2. Engines

2.1.3. Full load diagram



Full load diagram F30, 328i with N20B20O0 engine in comparison to the N52B30O1 engine

2.2. N55 engine

The N55 engine is the successor to the N54 engine and is already in use in numerous BMW models, for example in the F07, F10 and F25. Technical updates and modifications make it possible to use only one exhaust turbocharger. The technical data have remained virtually the same - with reduced costs and improved quality.

F30 Powertrain
2. Engines

2.2.1. New features/changes

Engine mechanics

- Crankcase adapted for twin-scroll exhaust turbocharger
- Cylinder bore changed to 84 mm
- Large longitudinal ventilation bore holes in the crankcase
- Modified oil supply of vacuum pump
- Water duct for injector cooling integrated in the cylinder head
- Crankcase ventilation and blow-by pipe integrated in the cylinder head cover
- Asymmetrical counterweight arrangement of crankshaft and weight reduction
- Profiled bore hole in small connecting rod eye
- Unleaded connecting rod bearing shells.

Valve gear

- Variable camshaft timing control (VANOS)
  - Solenoid valves with integrated non-return valve and 3 strainers
  - Increased adjustment speed and reduced susceptibility to dirt
- Valvetronic VTC
  - Integrated in the cylinder head and revised
  - Brushless servomotor, 3rd generation
  - Position identifier for eccentric shaft integrated in the servomotor.

Belt drive

- Belt drive and vibration absorber newly developed.

Oil supply

- Intake pipe, oil deflector and oil collector integrated in one component
- Oil pump with thermoset slide and map control
- Modified oil filter housing.

Air intake and exhaust emission systems

- Twin-scroll exhaust turbocharger with wastegate valve and electrical blow-off valve
- Air-gap-insulated exhaust manifold, six into two
- Upstream catalytic converter
- Discontinuation of underbody catalytic converter.

F30 Powertrain
2. Engines

Vacuum system

- Revised, similar to N63 engine.

Fuel preparation

- Direct fuel injection with central injector position and up to 200 bar fuel injection pressure
- Solenoid valve injectors.

Cooling

- Coolant channels revised for exhaust turbocharger.

Engine electrical system

- Crankshaft sensor integrated for automatic engine start-stop function
- Engine-related Digital Engine Electronics DME (MEVD 17.2.6) secured to air intake system and cooled using intake air, FlexRay-compatible
- Improved signal quality and temperature resistance of the hot-film air-mass meter HFM
- Adoption of oxygen sensor before catalytic converter from the N63 engine
- New oil pressure sensor for absolute pressure measurement
- Oil temperature sensor screwed into main oil duct
- Ignition coils with higher ignition voltage and improvement of the electromagnetic compatibility
- Spark plugs analogous to N63 engine
- Solenoid valve injectors.

For more information please refer to the "N55 Engine"training material ST916.

2.2.2. Technical data

		N55B30M0 F30, 335i US version
Design		R6
Valves per cylinder		4
Engine control		MEVD 17.2
Displacement	[cm^3]	2979
Stroke/bore	[mm]	89.6/84.0
Power output at speed	[kW (HP)] [rpm]	225 (300) 5800
Torque at speed	[Nm (ft-lbs)] [rpm]	400 (300) 1300 – 5000

F30 Powertrain
2. Engines

		N55B30M0 F30, 335i US version
Compression ratio	[ε]	10.2 : 1
Fuel grade		RON 91 – 98
Exhaust emission standards		Ultra Low Emission Vehicle (ULEV) II
Fuel consumption (manual/automatic transmission)	[l/100 km]	---
Acceleration 0 – 100 km/h (manual/automatic transmission)	[s]	5.7/5.7

2.2.3. Full load diagram

When compared with its predecessor, the N55 engine is characterized by lower fuel consumption with identical power and torque data.

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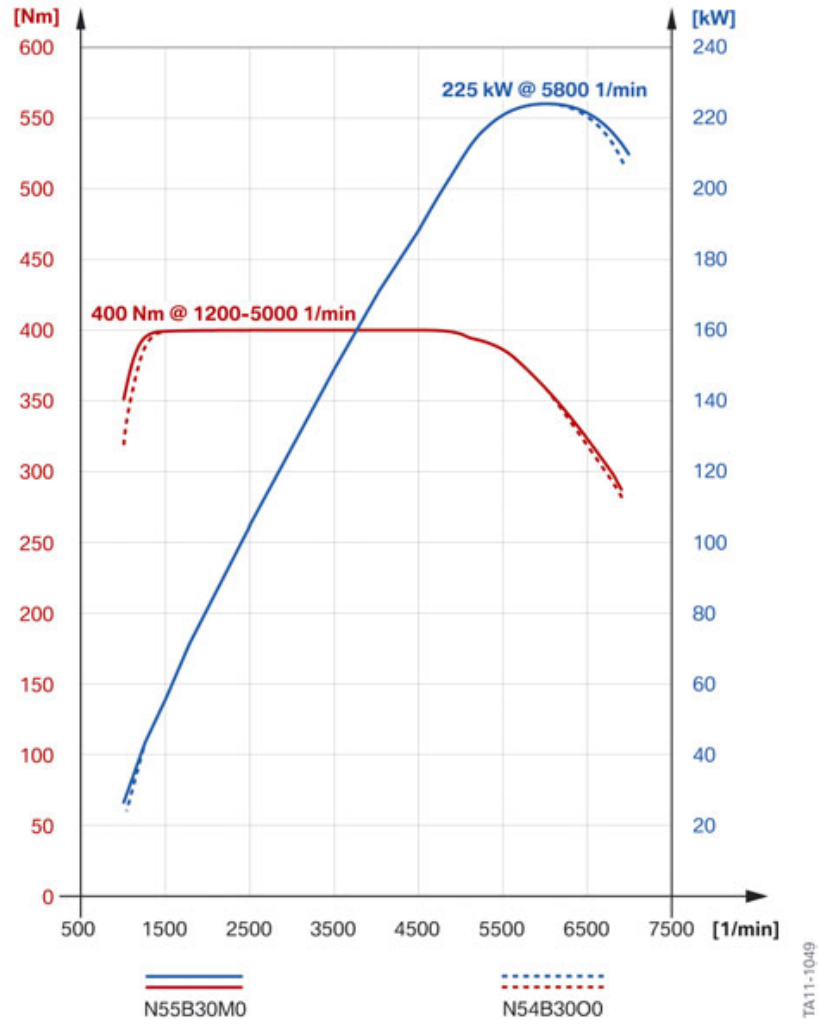
2. Engines



Full load diagram F30, 335i with N55B30M0 engine in comparison to the N54B30O0 engine

2.3. Engine oil level check

The F30 has an engine oil level check. Only the following messages can be displayed while the vehicle is being driven:

- Engine oil level OK
- Engine oil at minimum. Top up with 1 liter engine oil.
- Engine oil level below minimum. Top up with 1 liter of oil.

F30 Powertrain
2. Engines

2.3.1. Detailed measurement

Prerequisites:

- Vehicle standing on a level road with the engine running at normal at operating temperature
- Manual gearbox: gearshift lever in neutral, clutch and accelerator pedals not pressed
- Automatic transmission: selector lever in position N or P and accelerator pedal not pressed.

Measurement must be started from the Vehicle Information menu and takes roughly one minute, in the course of which the idle speed is automatically increased slightly. The engine oil level is then indicated on a scale.

2.4. Engine identification

2.4.1. Engine designation

In the technical documentation, the engine designation is used to ensure unambiguous identification of the engine. However, an abbreviated engine designation (e.g. N20) is often used which only allows the engine type classification.

Position	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW M Sport BMW M GmbH Bought-in engines
2	Engine type	1 2 4 5 6 7 8	4-cylinder in-line engine (e.g. N12) 4-cylinder in-line engine (e.g. N20) 4-cylinder in-line engine (e.g. N43) 6-cylinder in-line engine (e.g. N53) V8 engine (e.g. N63) V12 engine (e.g. N73) V10 engine (e.g. S85)
3	Change to the basic engine concept	0 1 – 9	Basic engine Changes, e.g. combustion process
4	Working method or fuel type and possibly installation position	B D H	gasoline, longitudinally mounted Diesel, longitudinally mounted Hydrogen

Position	Meaning	Index	Explanation
5 6	Capacity in liters Displacement in 1/10 liter	1 8	1 liters 0.8 liters equals 1.8 liters
7	Performance class	K U M O T S	Lowest Lower Middle Upper (standard) Top Super
8	Revision relevant to approval	0 1 – 9	New development Redesign

2.4.2. Engine identification

The engines have an identification mark on the crankcase to ensure unambiguous identification and classification. This engine identification is also necessary for approval by government authorities.

With the N55 engine, this identification has been subject to a further development, with the previous eight positions being reduced to seven. The engine number can be found on the engine below the engine identification. This consecutive number, in conjunction with the engine identification, permits unambiguous identification of each individual engine.

Position	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW M Sport BMW M GmbH Bought-in engines
2	Engine type	1 2 4 5 6 7 8	4-cylinder in-line engine (e.g. N12) 4-cylinder in-line engine (e.g. N20) 4-cylinder in-line engine (e.g. N43) 6-cylinder in-line engine (e.g. N53) V8 engine (e.g. N63) V12 engine (e.g. N73) V10 engine (e.g. S85)
3	Change to the basic engine concept	0 1 – 9	Basic engine Changes, e.g. combustion process
4	Working method or fuel type and possibly installation position	B D H	gasoline, longitudinally mounted Diesel, longitudinally mounted Hydrogen
5 6	Capacity in liters Displacement in 1/10 liter	1 8	1 liters 0.8 liters equals 1.8 liters
7	Type approval matters (changes which require a new type approval)	A B – Z	Standard as required, e.g. research octane number 87

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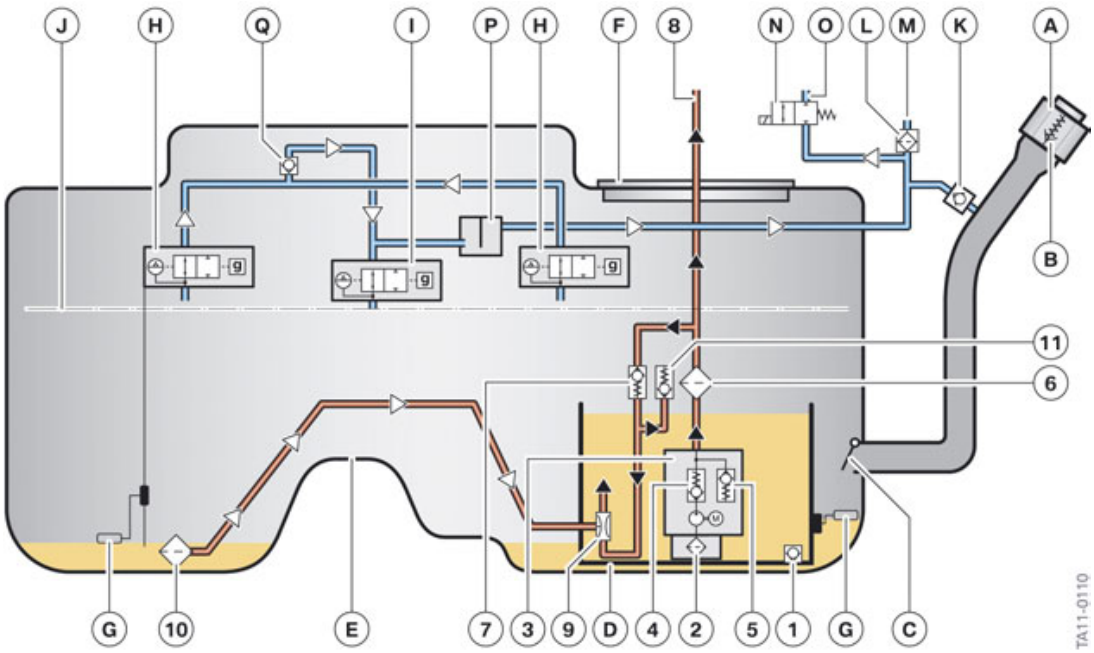
3. Fuel Supply

3.1. Gasoline

3.1.1. System overview



F30 fuel tank for gasoline engine

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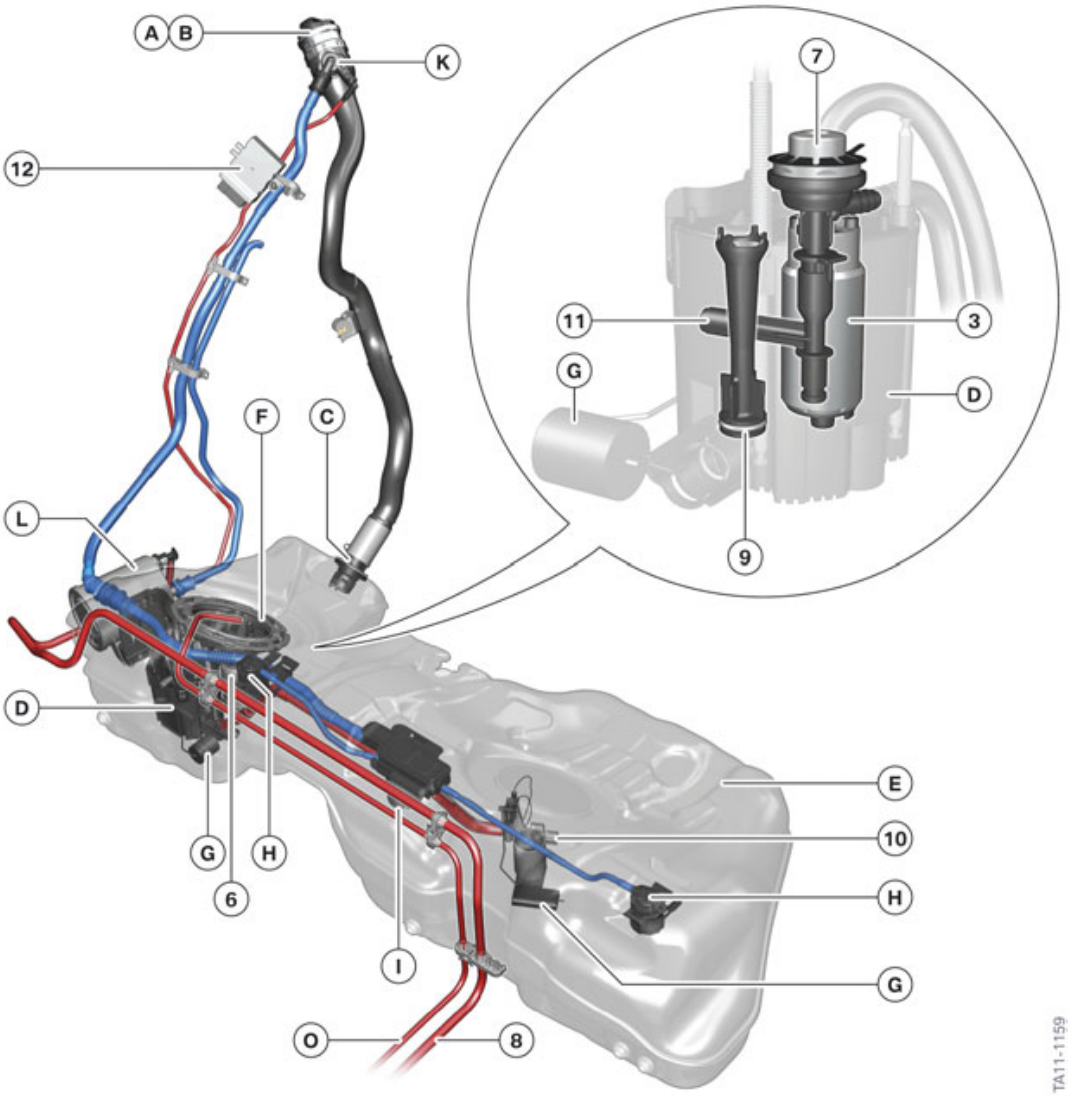
3. Fuel Supply



F30 fuel tank for gasoline engine (European version)

Index	Explanation
A	Fuel filler cap
B	Overpressure protection function (in the fuel filler cap)
C	Non-return valve
D	Surge tank
E	Fuel tank
F	Delivery module
G	Lever sensor

Index	Explanation
H	Service vent valve
I	Refuelling ventilation valve with fuel tank overfill protection facility
J	Maximum fill level (limited by refuelling ventilation valve)
K	Non-return valve (only in US version)
L	Carbon canister
M	Opening to environment
N	Tank vent valve (on engine)
O	Purge air line
P	Liquid trap
Q	Fuel tank overfill protection facility
1	First fill valve and surge tank inlet
2	Suction strainer
3	Electric fuel pump
4	Non-return valve (pressure holding function, delivery pressure)
5	Pressure-limiting valve
6	Fuel filter
7	Pressure regulator
8	Feed line
9	Suction jet pump
10	Intake pipe with coarse filter (suction jet pump transfer)
11	Pressure control valve (for suction jet pump)
12	Electronic fuel pump control EKPS

3.1.2. Fuel delivery

For vehicles with N20 or N55 engine the fuel tank has a volume of 60 liters. It is designed as a saddle tank on account of the installation area in the vehicle. The fuel supply system has a so-called delivery unit and a sensor unit. The delivery unit is accommodated in the right half, and the sensor unit in the left half of the fuel tank. The first fill valve (1) ensures that fuel is introduced into the surge tank during refuelling when the surge tank is completely empty. It also acts as an inlet, in that there is no active filling of the surge tank.

The fuel flows via the suction strainer (2) to the electric fuel pump (3) with non-return valve (4) and pressure limiting valve (5). It flows further via the fuel filter (6) with pressure regulator (7) to the feed line (8). The electric fuel pump sits in the surge tank and is adjusted via the electronic fuel pump control unit EKPS (12). The delivery pressure is configured at 5.8 bar.

The suction jet pump (9) conveys the fuel via an additional line from the left half of the fuel tank to the surge tank. The location of the suction jet pump (9) in the surge tank is new.

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3. Fuel Supply

When the engine is switched off, the delivery pressure is maintained for a certain amount of time on account of the hot-start response. The feed line cannot run dry, even after the dwell time, because air cannot get in with the system being airtight. The non-return valve (4) prevents the fuel tank from leaking in the event of damage to the lines on the engine or underbody.

3.1.3. Tank ventilation system

An overpressure protection function (B) is integrated in the fuel filler cap (A). The overpressure protection function ensures, in the event of a problem with the tank ventilation system, that any excess pressure that forms can escape and the fuel tank is not damaged. A non-return valve (C) is located at the end of the fuel filler neck. The non-return valve prevents fuel from sloshing back into the fuel filler neck. The non-return valve is closed by a spring so that it is fluid-tight.

The components in the fuel tank are accessible through the service opening on the right, which is an integral part of the delivery module (F).

The fuel level is detected via the two lever sensors (G).

The surge tank (D) ensures that enough fuel is always available to the electric fuel pump (3) for delivery. The surge tank is also an integral part of the delivery module and can thus be changed.

The refuelling ventilation valve with fuel tank overfill protection facility (I) is situated in a high position. The valve closes if the fill level reaches this height during refuelling. The air can no longer escape fast enough from the fuel tank, thereby causing the fuel in the filler pipe to rise and the fuel pump nozzle to cut out.

Ventilation is effected during operation while the refuelling ventilation valve is closed via the service vent valves (H). They have a smaller opening diameter they alone would not allow the air to escape fast enough from the fuel tank during refuelling. The service vent valves are arranged in such a way that ventilation is also possible when the vehicle is at an inclination of 18°.

The integrated fuel tank overfill protection facility is provided by a ball, which closes the vent hole as a result of its own weight. A fuel tank overfill protection facility is necessary to safeguard the compensation volume in the tank. When the refuelling ventilation valve has closed, in order to guarantee the compensating volume maintained in the tank an overpressure is built up in the tank by the integrated fuel tank overfill protection facility. This overpressure causes the fuel level in the fuel filler pipe to rise and thus the fuel pump nozzle to cut out.

During operation the pressure can rise due to the temperature increase. If the pressure in the fuel tank (fill level above the service vent valves) reaches approx. 30 mbar above the ambient pressure, the ball is lifted and the pressure can escape via the liquid trap (P). Entrained fuel is retained in the liquid trap and returned to the tank. In this way, ventilation is possible even when the fuel tank is full without the risk of overfilling.

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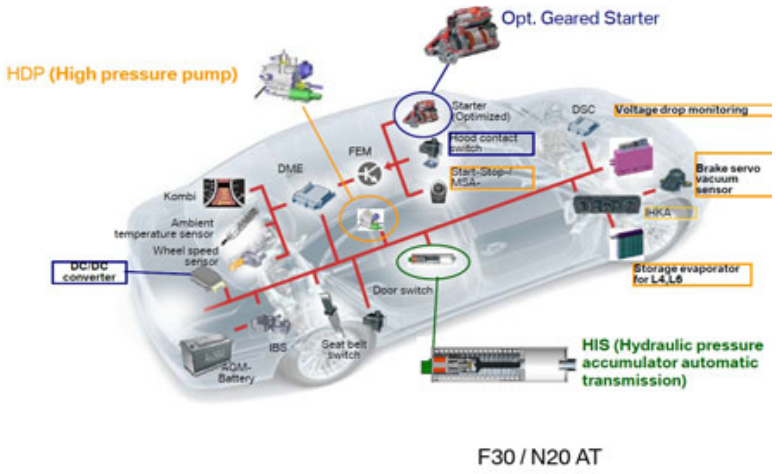
4. Automatic Start/Stop II (MSA II)

The F30 328i (N20), 335i (N55) are available with the MSA II system (as standard equipment) with both the manual and automatic 8 speed transmission.

MSA II system highlights:

- Air conditioning function is enhanced with the cold storage evaporator.
- The hydraulic pressure accumulator allows MSA II to operate with automatic transmissions.
- Driver presence detection via driver's seat belt and driver's door switch.



F30 / N20 AT

MSA II System Components

4.1. System Overview

4.1.1. Automatic start/stop function - Manual transmission

When the car is stopped and the driver engages neutral and releases the clutch pedal, the automatic start/stop function switches the engine off. This means that the vehicle does not use any fuel when it is at a standstill. When the driver depresses the clutch pedal again, the engine is automatically restarted and the driver can continue driving.

4.1.2. Automatic start/stop function - Automatic transmission

The automatic engine start-stop function switches off the engine when the vehicle is brought to a standstill, the selector lever remains in the D position, and the driver depresses the brake pedal to hold the vehicle at a standstill. This means that the car does not use any fuel when it is at a standstill. When the driver releases the brake pedal again, the engine is automatically restarted and the driver can continue driving.

The description that follows therefore deals specifically with the automatic start/stop function in conjunction with the automatic transmission.

The engine will NOT automatically turn OFF if:

- Outside temperature below 37.4˚F.
- Outside temperature above 95˚F.
- Vehicle interior is not yet warmed up or cooled down.
- Engine is not yet warmed up.
- Vehicle battery state of charge very low.
- After vehicle was driven in reverse.
- Steering wheel operated after vehicle stopped.
- Stop&Go Traffic.
- GWS selector in Sport/Manual mode.

If MSA is active (ENGINE OFF), the engine will be turned ON automatically if:

- Interior temperature cannot be maintained (cooling and heating).
- Windshield fogging.
- Vehicle battery state of charge drops below a threshold.
- Steering wheel input is detected.
- Change gear lever position from D to N; D to M/S; P to D.
- The accelerator and the brake pedal are pressed at the same time.
- ECO PRO mode activated.

4.1.3. DC/DC converter

The higher frequency of starting operations in vehicles with the automatic start/stop function can lead to voltage dips in the vehicle electrical system. One DC/DC converter is installed in order to protect specific voltage-sensitive components (depending on the vehicle equipment).

The DC/DC converter supplies a constant voltage to the 30B_DC/DC terminals, also during the starting operation.

A DC/DC converter is installed only if the following options are installed:

- Harmon Kardon Surround Sound System (SA 688)
- Navigation system (optional 609)

Note: For a detailed explanation of how the DC/DC converter operates refer to the MSA I section of the ST1112 training material.

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4. Automatic Start/Stop II (MSA II)

4.2. Automatic mode

The automatic start/stop function is ready for operation following every engine start.

The function is activated once the vehicle reaches a specific speed:

- Vehicles with manual transmission: > 5 km/h/3 mph.
- Vehicles with automatic transmission: > 9 km/h/5 mph.

The driver presence detection via the seat belt buckle switch and also via the door contact has been introduced as a new feature of MSA II.

When the driver leaves the vehicle, the automatic start/stop function is deactivated, in order to prevent the engine from starting automatically.

The MSA function is always reactivated if:

- the driver's seat belt is fastened and the vehicle is travelling at a speed of > 5 km/h/3 mph
- the driver's door is closed and the vehicle is travelling at a speed of > 5 km/h/3 mph*.

* > 9 km/h/5 mph - vehicles with automatic transmission

The prerequisites for deactivation of the automatic start/stop function vary, depending on which switching mode the seatbelt buckle switch and door contact are in when the automatic start/stop function is activated:

Status during activation of automatic start/stop function	Prerequisites for deactivation of automatic start/stop function
• The driver's seat belt is fastened. • The driver's door is closed.	The driver unfastens the seat belt buckle and opens driver's door.
• The driver's seat belt is **not** fastened. • The driver's door is closed.	The driver opens the driver's door.
• The driver's seat belt is fastened. • The driver's door is opened.	The driver unfastens the seat belt buckle.

The automatic start/stop function is reactivated if:

- the seat belt buckle is fastened and/or the driver's door is closed and the engine has been started
- the seat belt buckle is fastened and/or the driver's door is closed and the vehicle is travelling at a speed of > 5 km/h/3mph*.

* > 9 km/h/5mph - vehicles with automatic transmission

F30 Powertrain

4. Automatic Start/Stop II (MSA II)

4.2.1. Driving

The purpose of the automatic start/stop function is to switch the engine off when the vehicle is at a standstill. As long as the vehicle is in motion the driver will not be aware of the automatic start/stop function.

Index	Explanation
1	Vehicle moving
2	Selector lever in drive position D, driver operates accelerator pedal
3	Engine running, the driving situation is reflected by the engine speed display and fuel consumption display

4.2.2. Stopping

From the driver's point of view, the stopping process with subsequent engine stop is as follows:

Index	Explanation
1	Vehicle slows to a standstill, e.g. at a red light
2	Selector lever remains in the "D" drive position, driver depresses the brake pedal to decelerate and hold the vehicle at a standstill
3	The engine is switched off after roughly 1 second, "0" engine speed will be displayed on the tachometer with the needle reading “Ready”.

In the situation depicted above the driver holds the car at a standstill by depressing the brake pedal.

Alternatively, the driver can select selector lever position "P" and release the brake pedal. The engine remains switched off. If then the drive position "D" is subsequently engaged, the engine starts without delay.

4.2.3. Driving off

The driver indicates his intention to drive off by releasing the brake pedal.

If the driver previously held the car at a standstill by depressing the brake pedal, the engine starts as soon as the driver releases the brake pedal.

Index	Explanation
1	Driver wishes to continue the journey (e.g. green light)
2	The selector lever remains in drive position "D", driver releases the brake pedal
3	Engine is started, revolution counter and fuel consumption display revert back to normal to reflect the driving situation

If the driver moves the selector lever into position "P" after the engine was switched off automatically, the engine starts automatically if the selector lever is now moved to position "D".

During this process, the automatic engine start is not activated automatically via a signal from the brake light switch, but by the DSC control unit that monitors the brake pressure.

4.2.4. Establishing start-up readiness

If the driver wants to start the engine but not yet drive off, he can establish start-up readiness by:

- Pressing the brake pedal briefly, applying more force
- Releasing the brake pedal slightly

Both of these actions will prompt the engine to start automatically.

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4. Automatic Start/Stop II (MSA II)

4.2.5. Automatic hold

If the driver has activated the "Automatic Hold" function, he/she can also release the brake pedal once the vehicle has come to a standstill. The automatic start/stop function also switches the engine off in this case. The car is held at a standstill by the DSC hydraulics. The engine only starts if the driver operates the accelerator pedal.

4.2.6. Preventing automatic engine shutdown

In order to be able to drive off quickly, e.g. at a crossing, the automatic engine shutdown can be actively prevented if within one second after the vehicle comes to a standstill the brake pedal is pressed briefly, applying more force than usual, then immediately held with the usual brake pedal force.

Index	Explanation
1	Vehicle slows to a standstill, e.g. at a red light
2	Immediately after the vehicle comes to a standstill (within one second) the brake pedal is pressed briefly, applying more force than usual, then immediately held with the usual brake pedal force
3	The engine continues running

4.3. Switch-off inhibitors

Under certain conditions it is necessary to suppress the MSA function:

- the vehicle is coasting (vehicles with manual transmission only)
- the brake vacuum is too low (vehicles with manual transmission only)
- the brake pedal is not pressed firmly enough which means the vehicle is detected as not being held sufficiently (vehicles with automatic transmission only)
- the vehicle stops on uphill/downhill gradients > 12%
- the steering angle is > 6°
- the steering wheel movement is not yet complete (as otherwise insufficient support will be provided by the power steering as a consequence)

- the vehicle was not driven at a speed of > 5 km/h/3 mph* following the previous engine shut-down
- the engine is not running at idle speed (accelerator pedal is being pressed)
- the vehicle is being driven in reverse
- the Hill Descent Control (HDC) has been activated
- the operating temperature of the engine is too low
- the carbon canister is being purged
- the fuel grade is insufficient
- the gearbox adaptation is active (vehicles with automatic transmission only)
- the hydraulic pressure accumulator is not charged yet (vehicles with automatic transmission only)
- stop-and-go traffic
- the state of charge is too low
- the ambient temperature is below +3 °C/ 37.4 °F (ice warning)
- the ambient temperature is above +35 °C/ 95 °F (with heating and air conditioning system switched on)
- the condensation sensor of the IHKA detects fogging of the windshield
- the heating and air conditioning system is switched on but the passenger compartment has not yet warmed up or cooled down to the required temperature
- the brakes have been applied via ABS.

* > 9 km/h/5 mph - vehicles with automatic transmission

4.4. Switch-on prompts

Conversely, it may be necessary to start the engine under the following conditions:

- the vehicle is not sufficiently held by the released brake pedal (vehicles with automatic transmission only)
- the steering wheel is moved
- the engine is not running at idle speed (accelerator pedal is being pressed)
- the transmission changes from "P" to "D"; the driver previously shifted from "D" to "P" when the engine was automatically switched off (vehicles with automatic transmission only)
- the transmission changes from "D" to "N" or "R" (vehicles with automatic transmission only)
- the state of charge is too low
- the ambient temperature is above +35 °C/95 °F (with heating and air conditioning system switched on)
- the condensation sensor of the IHKA detects fogging of the windshield
- the evaporator temperature is too low to ensure sufficient climate control.

F30 Powertrain

4. Automatic Start/Stop II (MSA II)

4.5. Deactivation

If a deactivation condition exists, the automatic start/stop function is deactivated.

The following scenarios arise, depending on when the deactivation condition for the automatic start/stop function occurred:

- the engine continues running and is no longer stopped automatically
- the engine was stopped automatically and starts once again automatically
- the engine was stopped automatically and no longer starts automatically (the Check Control message "MSA off" appears - the start/stop button must be operated in order to the start the engine).

The following deactivation conditions may occur:

- the driver's absence has been detected
- the engine did not start when starting
- the engine compartment lid is unlocked
- a fault related to the automatic start/stop function has been detected at the engine, transmission or components involved in the automatic start/stop function
- the bus communication is faulty
- the automatic start/stop function has been deactivated via the automatic start/stop function button
- the automatic start/stop function was deactivated via the diagnosis system
- the vehicle is in transport mode
- the engine was stalled.

The individual statuses can be read out using the diagnosis system.

An easy-to-follow example of a deactivation with subsequent switch-on request:

- the automatic start/stop function is deactivated via the automatic start/stop function button in the automatic engine shutdown phase
- as a consequence, the engine starts automatically
- after this, no further automatic engine shutdowns occur, the automatic start/stop function remains deactivated.

F30 Powertrain

4. Automatic Start/Stop II (MSA II)

4.5.1. Deactivation via automatic start/stop function button

F30 automatic start/stop function button location

The automatic start/stop function can be deactivated manually via the automatic start/stop function button (1). The LED in the button lights up when the function is deactivated. The automatic start/stop function is reactivated each time the engine is restarted.

4.6. Hydraulic pressure accumulator

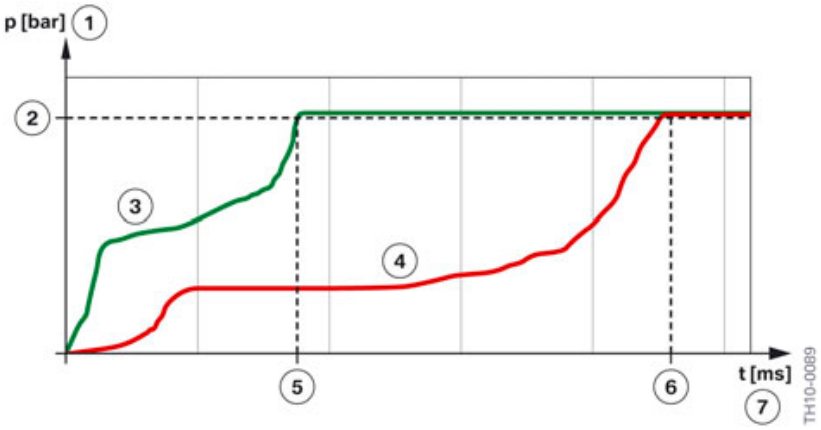
When the automatic start/stop function is activated the engine may shut off once the vehicle is at a standstill, the engine restarts automatically as the driver releases the brake to drive off.

In these engine stop phases the transmission oil pump is not driven, thus the fluid pressure supply ceases, the gearshift elements open, and there is no longer a transfer of power in the transmission. Maximum transmission oil pressure is required in order for the drive off process to take place dynamically without a noticeable delay when the automatic start/stop function is activated. However, the mechanically driven transmission oil pump cannot build up pressure quickly enough while the engine is starting.

A hydraulic pressure accumulator is therefore used in the automatic transmission for this purpose (as with F04). With the volume of transmission fluid stored in the hydraulic pressure accumulator, the shift elements can be filled as soon as the engine is started, even before the transmission oil pump has built up the necessary pressure to drive off.

F30 Powertrain

4. Automatic Start/Stop II (MSA II)



Variation in transmission oil pressure over time at engine start

Index	Explanation
1	Transmission oil pressure
2	Nominal value of the transmission oil pressure which is required to hydraulically actuate the shift elements
3	Characteristic of the transmission oil pressure **with** hydraulic pressure accumulator
4	Characteristic of the transmission oil pressure **without** hydraulic pressure accumulator
5	Point at which the automatic transmission **with** hydraulic pressure accumulator is ready to drive off
6	Point at which the automatic transmission **without** hydraulic pressure accumulator is ready to drive off
7	Time

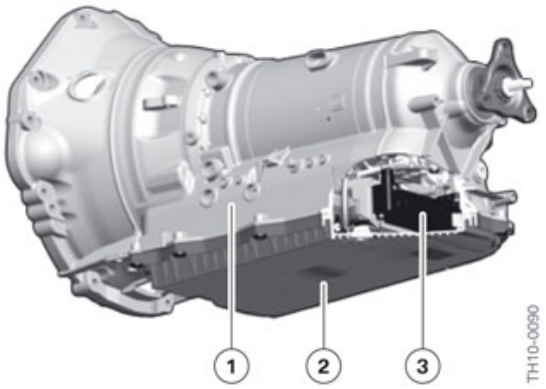
4.6.1. Installation location

The hydraulic pressure accumulator is integrated in the automatic transmission. It is located in the transmission oil sump, in the direction of travel behind the mechatronics module.

The hydraulic pressure accumulator can be replaced as a separate component.

F30 Powertrain

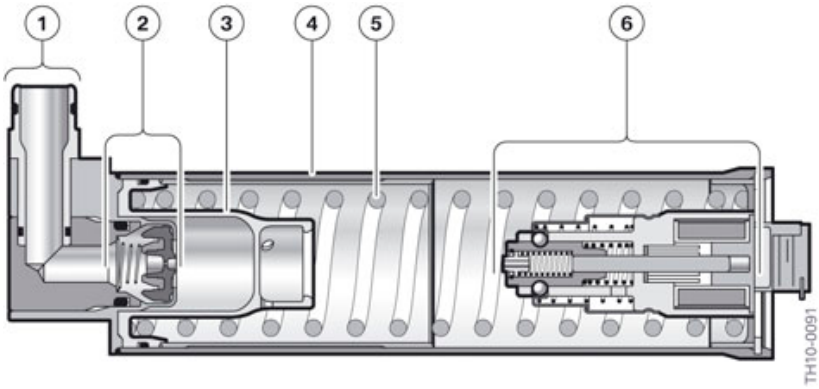
4. Automatic Start/Stop II (MSA II)



8–speed automatic transmission cutaway

Index	Explanation
1	Transmission housing
2	Transmission oil sump
3	Hydraulic pressure accumulator

4.6.2. Design



Design of hydraulic pressure accumulator

Index	Explanation
1	Connection to hydraulic system of automatic transmission
2	Throttle and non-return valve
3	Hydraulic piston
4	Hydraulic cylinder
5	Coil spring
6	Electromechanical latch mechanism

The hydraulic pressure accumulator consists of a hydraulic cylinder. This cylinder contains a piston that moves against the force of a spring. The piston can be electromechanically locked in the tensioned end position. The electromechanical latch mechanism incorporates locking balls, a tension spring, a release spring, and a solenoid.

The solenoid is activated and deactivated by the EGS. A corresponding wiring harness to the hydraulic pressure accumulator is laid inside the transmission housing.

The cylinder of the hydraulic pressure accumulator is connected to the transmission's hydraulic system directly (without any valves between them). The hydraulic pressure accumulator in fact contains an element which functions as a throttle and non-return valve. The throttle limits the volumetric flow of the fluid while the hydraulic pressure accumulator is being filled. In general, this filling operation corresponds to the charging operation of the accumulator which is why the expressions "charging" or "discharging" are used in this description.

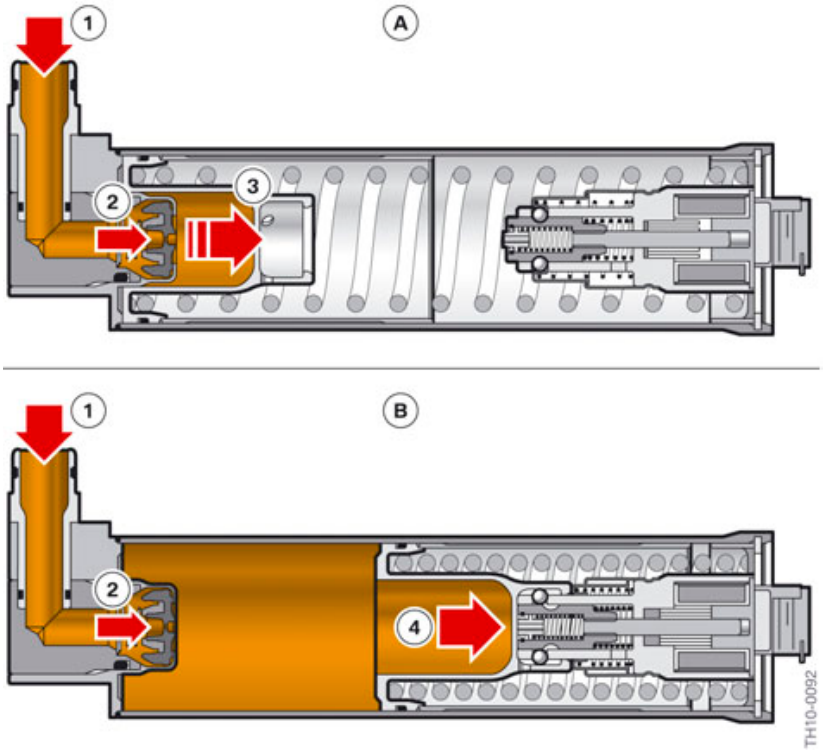
The non-return valve ensures that the transmission fluid flows into the hydraulic pressure accumulator via the throttle during charging. The transmission fluid does not flow through the throttle during the discharging process, the non-return valve now opens instead to allow an unrestricted flow of transmission fluid back into the hydraulic system. The purpose of the non-return valve is therefore not to maintain the pressure in the charged state. In the charged state, the transmission fluid in the hydraulic pressure accumulator is depressurized and the energy is stored in the tensioned spring.

4.6.3. Charging

The hydraulic pressure accumulator is therefore always charged when the engine is running and the transmission oil pump is working. During charging transmission fluid flows through the throttle into the hydraulic cylinder. In the process only a small volume is drawn from the hydraulic system so that the pressure level does not drop unintentionally. The transmission fluid pushes on the piston which acts against the spring force increasing the tension on the spring.

F30 Powertrain

4. Automatic Start/Stop II (MSA II)



Charging of the hydraulic pressure accumulator

Index	Explanation
A	Discharged state - charging procedure starts
B	Charged state - charging procedure ends
1	Transmission fluid flows from the hydraulic system of the automatic transmission into the hydraulic pressure accumulator
2	Volumetric flow of the transmission fluid is limited by the throttle
3	The transmission fluid exerts force on the piston which moves and tensions the coil spring
4	Transmission fluid exerts a force on the piston so that it is held in the "charged" end position

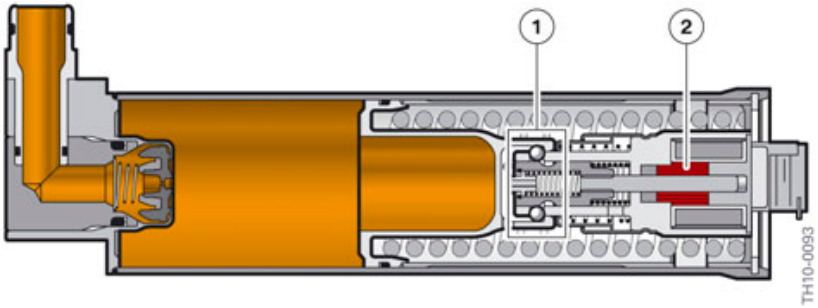
At the end of the charging process the piston travels past the latch mechanism (locking balls) until it reaches the end/stop. The transmission fluid pressure holds the piston against the spring force in the end position.

The latch mechanism does not engage yet. The hydraulic pressure accumulator is fully charged in this end position.

4.6.4. Locking

When the engine is switched off (while the hydraulic pressure accumulator is charged) the transmission oil pressure drops causing the spring to be released slightly. This allows the piston to slide into the locked position where locking balls hold the piston mechanically in place.

The now energized solenoid holds the inner slide in place so that the locking balls cannot enter the channels designated for releasing the lock. The electric power used for this is low (< 10 W) and is only required while the engine is off. Therefor the additional energy consumption of the hydraulic pressure accumulator viewed over an entire driving cycle is very low.



Charged and locked state of the hydraulic pressure accumulator

Index	Explanation
1	Mechanical latch mechanism
2	Solenoid activated

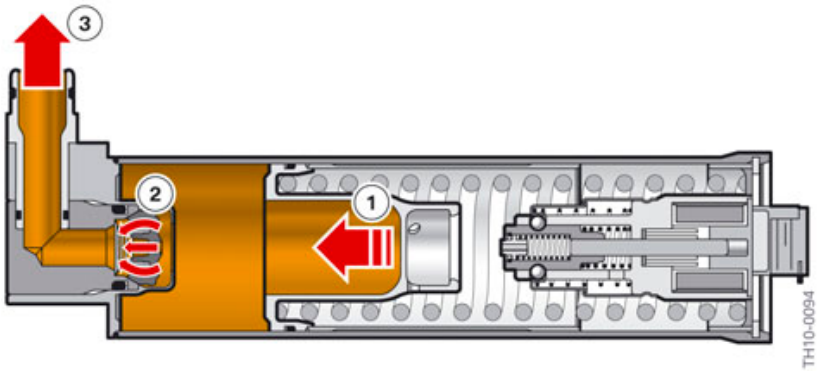
4.6.5. Discharging

When the engine is started, as the driver wants to drive off, the gearshift elements in the automatic transmission for driving off must be engaged. The hydraulic pressure accumulator supplies the transmission fluid pressure required for this during the discharging process.

As the solenoid is deactivated for discharging the inner slide (driven by a small spring) moves in the direction of the locking balls. This allows the balls to enter the channels designated for releasing the lock which in turn releases the piston. The spring (compressed during the charging process) exerts force on the piston which pressurizes the transmission fluid in the cylinder.

F30 Powertrain

4. Automatic Start/Stop II (MSA II)



Discharging of the hydraulic pressure accumulator

Index	Explanation
1	The large spring pushes on the piston, which in turn, forces the transmission fluid out of the hydraulic cylinder
2	Transmission fluid can now flow through the throttle **and** the opened non-return valve
3	Transmission fluid flows from the hydraulic pressure accumulator back into the hydraulic system of the automatic transmission

The piston moves (in the graphic to the left) and thereby pushes the transmission fluid back into the transmission hydraulic system. The transmission fluid exits the cylinder through the now opened non-return valve and throttle.

The oil volume forced back into the hydraulic system of the transmission is sufficient to engage the gearshift elements needed for the driving off process. This system is designed to provide the initial fluid pressure needed for the transmission to go into “Gear” at the exact moment just before the engine is started. As soon as the engine is started, the transmission fluid pressure is then again generated by the transmission oil pump and the entire process is restarted.

4.7. Service information

For information on servicing/diagnosing the MSA II system, refer to ST1112 Automatic Start/Stop (MSA) training material.

F30 Powertrain

5. Manual Gearboxes

In the F30 all the engine variants are equipped as standard with manual gearboxes.

5.1. Designation

The transmission designation in the technical documentation allows it to be uniquely identified. In frequent cases, however, only a short designation is used. such as I, K, or G is used to identify the transmission. For the correct designation, refer to the following table.

Position	Meaning	Index	Explanation
1	Designation	G	Transmission
2	Type of transmission	S	Manual gearbox
3	Number of gears	1 – 9	Number of forward gears
4	Type of transmission	- X S W D Y	Manual gearbox All-wheel drive vehicle with manual transmission Sequential Manual Gearbox SMG All-wheel drive vehicle with sequential manual transmission Twin-clutch gearbox All-wheel drive vehicle with twin-clutch gearbox
5 + 6	Transmission type	17 26 37 45 53	I gearbox D transmission H transmission K transmission G transmission
7	Gear train	B D S P	gasoline engine ratio Diesel engine ratio (w) Sport ratio gasoline engine ratio, revised
8	Manufacturer	G J R Z H	Getrag Jatco General Motors Powertrain Zahnradfabrik Friedrichshafen In-house part

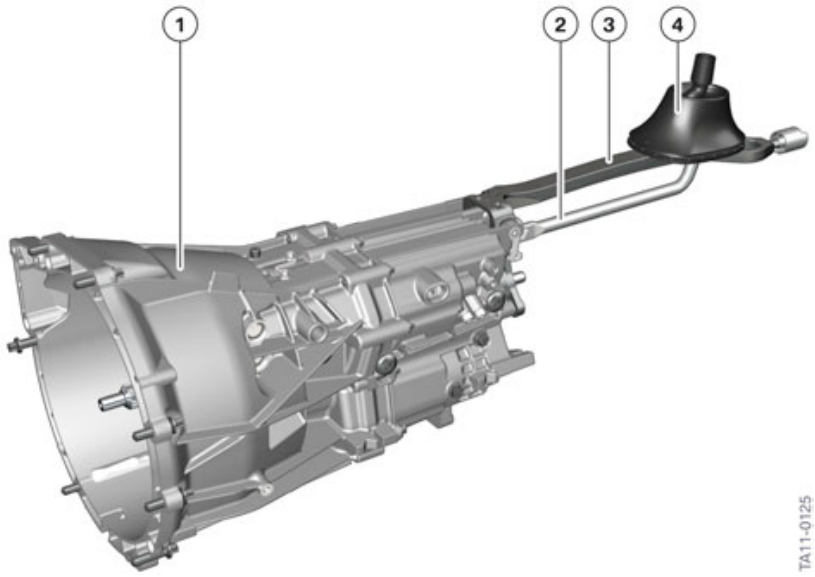
5.2. Variants

Model	Engine	Transmission designation	
BMW 328i	N20B20O0	GS6-17BG	I-350 Turbo transmission
BMW 335i	N55B30M0	GS6-45BZ	K transmission

F30 Powertrain

5. Manual Gearboxes

5.3. I gearbox



F30 I gearbox

Index	Explanation
1	GS6-17BG gearbox
2	Gearshift rod
3	Gearshift arm
4	Gaiter

The I transmission is a 6-speed manual gearbox with two-piece die-cast aluminium housing. The different engine applications can be covered with a variation of the clutch housing. The main housing is the same for all variants.

For the I Turbo transmission, the transmission ratio was adapted to the power characteristics of the turbo engines. In the F30 the I Turbo transmission is used. I–350 turbo transmission in the BMW 328i.

5.3.1. I Turbo manual gearbox

New features/changes

- Gear set optimized for turbo engines
- Improvement to behavior of vehicle in the event of a crash through reinforced transmission mounting and a new gear safety bearing
- Clutch housing extended to the fixture of the centrifugal pendulum in the N20 engine
- Screw connection on engine standardized to M10 thread
- Ground connection to the body for the first time.

F30 Powertrain
5. Manual Gearboxes

Gears

To minimize the gearbox noise the running gears have been designed as high gears with a particularly large helix angle and have been optimized in terms of their coverage.

Bearings

The main bearings have a fundamental influence on the operational smoothness and the switching precision of the transmission. Play changes due to temperature fluctuations or an increase in the play during operating time are avoided by the exclusive use of grooved ball bearings and roller bearings.

The main bearings are designed as so-called "clean bearings". They are protected against dirt with a cover and are thus oil-permeable. The operating safety is therefore increased and the use of smaller, lighter bearings is possible.

Lubrication

The use of a life-time oil filling (capacity 1.4 liter). Together with the dirt-resistance of the bearings, an optimal combination of a long service life with no maintenance is achieved.

Synchronization

In the first and second gear double taper synchronizations are used. All other gears are designed as single taper synchronization.

Acoustics

A very precise and smooth gearshift is achieved by:

- The shift gate installed in the transmission
- The low-friction gearshift shaft in a ball sleeve
- The use of gearshift forks.

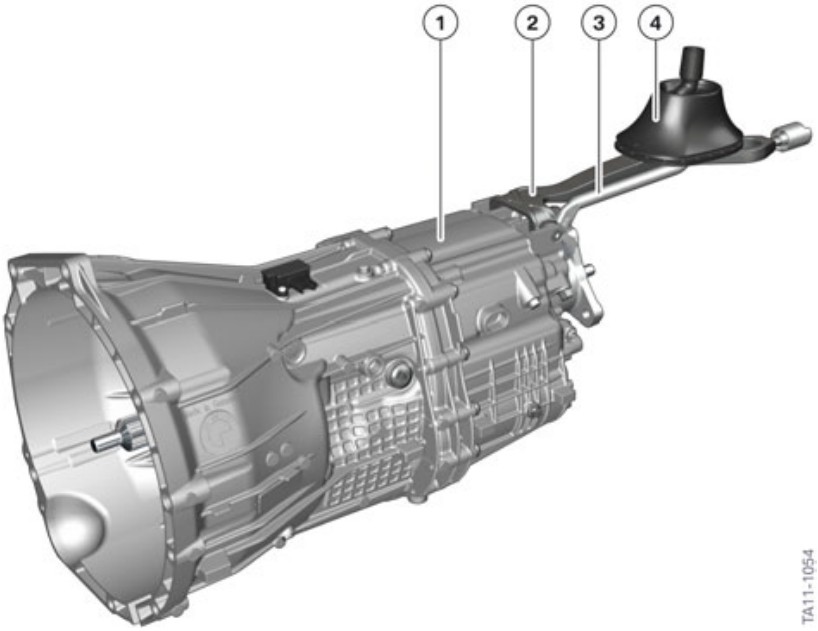
The passive lock guarantees locking safety with optimized ease of movement.

5.3.2. Technical data

		I-350 Turbo
Transmission designation		GS6-17BG
Maximum drive torque	[Nm]	350
Transmission ratio 1st gear		3.6933
Transmission ratio 2nd gear		2.0619
Transmission ratio 3rd gear		1.3134
Transmission ratio 4th gear		1.0000

	I-350 Turbo
Transmission ratio 5th gear	0.8092
Transmission ratio 6th gear	0.6771
Transmission ratio reverse gear	3.3484

5.4. K transmission



F30 K gearbox

Index	Explanation
1	Gearbox GS6-45BZ
2	Gearshift arm
3	Gearshift rod
4	Gaiter

The K transmission is a 6-gear inline manual gearbox in a countershaft design.

Instead of the G gearbox, the smaller, lighter and more cost-effective gearbox can be used in the N55B30M0 engine. The weight advantage is approx. 11 kg depending on the engine application. The gearbox's high transmission capability with at the same time small size and weight is essentially achieved by intermediate mounting of the main shafts and a modified gear train concept.

F30 Powertrain
5. Manual Gearboxes

5.4.1. Special features

- Six-speed gearbox with optimized transmission ratios
- Intermediate bearings
- Dry-sump lubrication
- Reduction in consumption (approx. –2% compared to G manual gearboxes)
- Reduced weight (approx. –11 kg compared to G manual gearboxes)
- Synchromesh units with carbon friction linings
- Life-time oil filling
- Zero-gear sensor for automatic engine start-stop function.

The gearshift quality is significantly improved by

- The use of a newly developed carbon friction lining on the synchromesh units
- Newly developed and very low-friction shift mechanism
- The low drag losses of the gear train
- The minimal overshift travel.

To keep the drag losses low, dry-sump lubrication is used for the first time. Compared with conventional immersion lubrication, this prevents the swash losses from the movement of the gear train in the sump oil. Further reduction of losses is achieved by the friction-optimized radial shaft seals.

5.4.2. Technical data

		K transmission
Transmission designation		GS6-45BZ
Maximum drive torque	[Nm]	470
Wheelbase	[mm]	80
Weight incl. oil	[kg]	43.3
Gearbox length	[mm]	646
Transmission ratio 1st gear		4.110
Transmission ratio 2nd gear		2.315
Transmission ratio 3rd gear		1.542
Transmission ratio 4th gear		1.179
Transmission ratio 5th gear		1.000
Transmission ratio 6th gear		0.846
Transmission ratio reverse gear		3.372

F30 Powertrain
5. Manual Gearboxes

5.4.3. Intermediate bearings

In countershaft-design manual gearboxes the main shaft is pressed away from the countershaft by the gearing forces. This gives rise to a deviation of the ideal gearing contact pattern, which results in a significant deterioration in the strength of the gearing and the acoustics.

The K gearbox therefore makes use of intermediate bearings which significantly limit shaft bending. In this way, compared with conventional gearboxes, higher torques can be transmitted and the gearing acoustics can be simultaneously improved.

5.4.4. Dry-sump lubrication

The lubrication method used in conventional manual gearboxes is usually immersion lubrication. The gear wheels on the countershaft are immersed into the gearbox oil and distribute it as the gear train rotates in an uncontrolled fashion through the entire gearbox. Additional equipment such as oil bulkheads or oil ways is often required to deliver the oil to the gearing, the bearings or the synchromesh units.

The K gearbox uses for the first time a dry-sump lubrication system, consisting of

- Oil filter
- Oil pump
- Injection pipe.

This system utilizes less energy than an immersion lubrication system to deliver lubricating oil specifically to the gearing, the bearings and the synchromesh units. Controlled oil routing also results in improved temperature management, in that cooling air from the underbody area is specifically directed into the area of the filter intake opening. In this way, the gearbox oil is subjected to continuous cooling.

The oil filter also improves the oil quality and with it the load capability of the gearing.

5.4.5. Synchromesh

Triple-band synchromesh units are used in 1st and 2nd gears. Single-band synchromesh units are installed in the other gears. These are equipped with a newly developed carbon friction lining for improving gearshift quality.

5.4.6. Mating dimensions

The mating dimensions for the gearbox mounting have been adopted from established series applications. In this way, integration in the vehicle environment has been significantly simplified, since it is possible to fall back on existing peripherals.

F30 Powertrain

6. Automatic Transmission

The F30 is available in all engine versions also with automatic transmission. The established GA8HP 8-speed automatic transmission is always used.

6.1. Designation

A unique designation is used for the transmission in the technical documentation so it can be clearly identified. In frequent cases, however, only a short designation is used. This short form is used so the transmission can be assigned to a transmission family. The GA8HP transmission family, consisting of the GA8HP45Z, the GA8HP70Z and the GA8HP90Z transmissions for example, are often mentioned.

Position	Meaning	Index	Explanation
1	Designation	G	Transmission
2	Type of transmission	A	Automatic transmission
3	Number of gears	6 8	Six forward gears Eight forward gears
4	Type of transmission	HP L R	Hydraulic planetary gear train Designation of General Motors Powertrain Designation of General Motors Powertrain
5 + 6	Transferable torque	19 26 32 45 (ZF) 45 (GMPT) 70 90 390	300 Nm gasoline engine 600 Nm gasoline engine 720 Nm gasoline engine 450 Nm gasoline engine, 500 Nm diesel engine 350 Nm gasoline engine 700 Nm gasoline engine and diesel engine 900 Nm gasoline engine 390 Nm, 4th gear 410 Nm, gasoline engine
7	Manufacturer	G J R Z H	Getrag Jatco GMPT ZF In-house part

6.2. Variants

Model	Engine	Transmission	Torque converter
BMW 328i	N20B20O0	GA8HP45Z	NW235ZDW
BMW 335i	N55B30M0	GA8HP45Z	NW235TDD

6.3. GA8HP45Z transmission

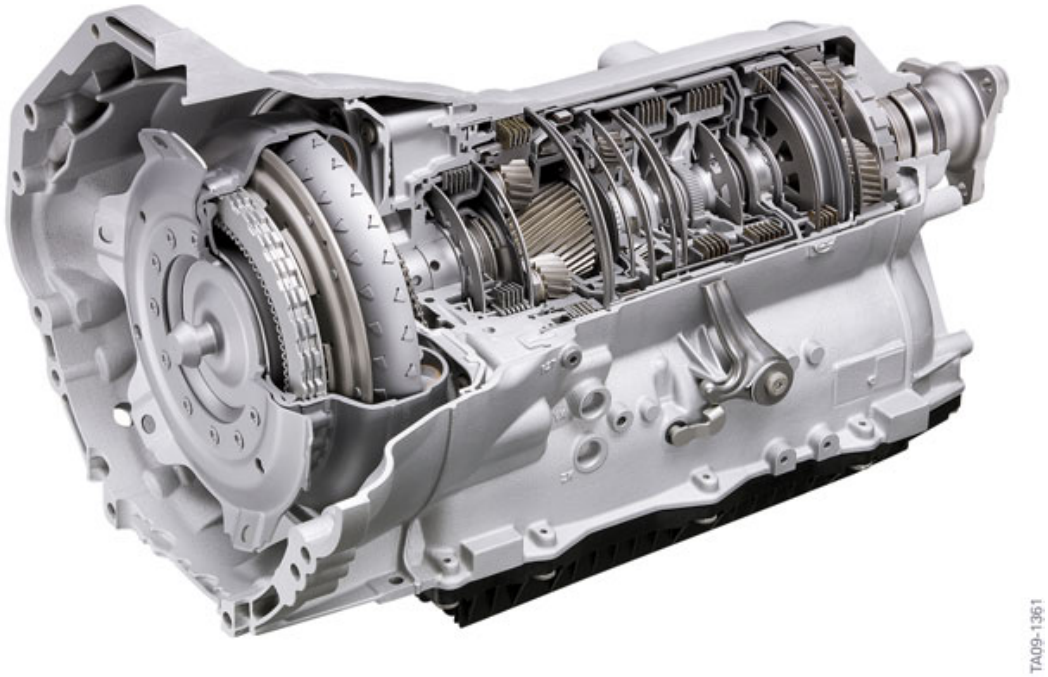
The GA8HP transmission is already familiar from being used in many BMW models.

There is also a Sport Automatic Transmission option available 2TB, this includes shift paddles on the steering wheel.

F30 Powertrain

6. Automatic Transmission

For a description of the 8-speed automatic transmission, please refer to the "GA8HP Automatic Transmission" Training information.



automatic transmission GA8HP

6.3.1. Technical data

		GA8HP45Z
Maximum power	[kW]	250
Maximum torque	[Nm]	450
Maximum permissible torque, 1st - 7th gear	[rpm]	7200
Maximum permissible torque, 8th gear	[rpm]	5700
Maximum permissible engine speed, reverse gear	[rpm]	3500
Transmission ratio 1st gear		4.714
Transmission ratio 2nd gear		3.143
Transmission ratio 3rd gear		2.106
Transmission ratio 4th gear		1.667
Transmission ratio 5th gear		1.285
Transmission ratio 6th gear		1.000

F30 Powertrain

6. Automatic Transmission

	GA8HP45Z
Transmission ratio 7th gear	0.839
Transmission ratio 8th gear	0.667
Transmission ratio reverse gear	3.295

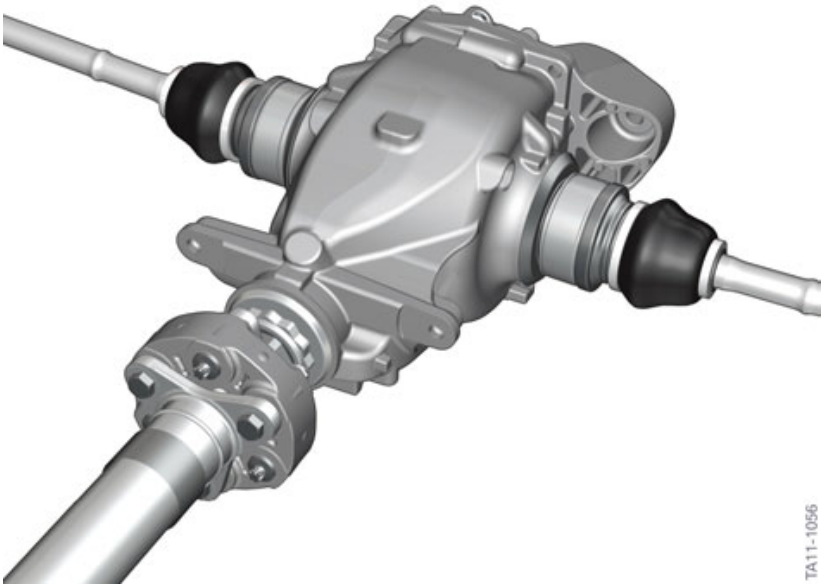
F30 Powertrain

7. Rear Axle Differential

The rear axle differential for the F30 is a further development of the low-friction rear axle differential already familiar from the E90 and F25.

For a description of the rear axle differential, please refer to the following Training Manuals:

- "E90 Complete Vehicle Powertrain" for the rear axle differential HAG 168L
- "F25 Powertrain Complete Vehicle" for the rear axle differential HAG 188LW and the rear axle differential HAG 215 LW.



F30 rear axle differential HAG 188LW

Special features

- Reduced transmission losses
- Optimized efficiency (approx. 1%) by
  - The use of lower-viscosity oil
  - Changing the material used for the radial shaft seals on the powertrain
  - Optimized lubrication of the pinion bearing
  - Crown wheel welded to expansion tank housing (previously screwed on).

F30 Powertrain

7. Rear Axle Differential

7.1. Designation

Position	Meaning	Index	Explanation
1 - 3	Type of transmission	HAG	Rear axle differential
4 - 6	Overall size	168/188/215	Diameter of crown wheel pitch circle in mm
7	Bearing (internal)	L	Low-friction bearing (angular-contact ball bearing)
8	Optimization stage	W	Efficiency-optimized

7.2. Variants

Model	Transmission	Rear axle differential	Gear ratio i
BMW 328i	GS6-17BG	HAG 188LW	3.91
BMW 328i	GA8HP45Z	HAG 188LW	3.15
BMW 335i	GS6-45BZ	HAG 215LW	3.23
BMW 335i	GA8HP45Z	HAG 188LW	3.15

F30 Powertrain

8. Shafts

8.1. Drive shafts

A variant of the drive shaft that is adapted to the torque requests is available for each engine-gearbox configuration.

Focal points in the design of the drive shafts in the were the torque transfer and comfort requirements with regard to acoustics and vibrations.

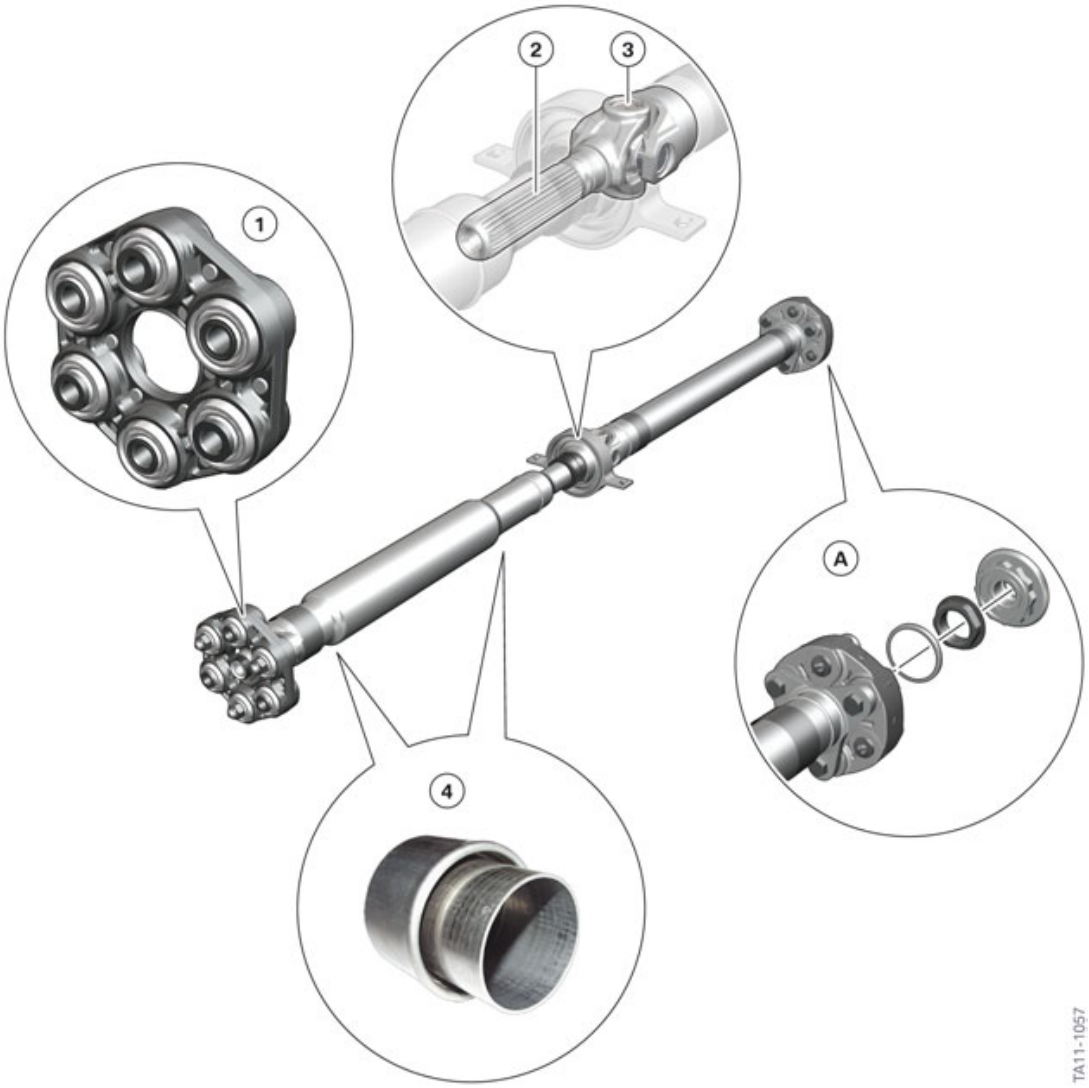
The joints, shaft divisions and shaft diameters have been designed to prevent disruptive noises or vibrations being passed on to the connection points at the body.

To minimize the high-frequency tooth meshing noise of the rear axle differential, the drive shaft for engines with a torque of over 270 Nm are secured to the rear axle differential with flexible discs. The drive shaft is always secured to the gearbox or automatic transmission using flexible discs.

Depending on the engine/gearbox configuration the steel drive shaft is available in different lengths. It is screwed to the gearbox or automatic transmission, connected to the rear axle differential.

F30 Powertrain

8. Shafts



F30 drive shaft

Index	Explanation
1	Flexible disc
2	Sliding piece
3	Universal joint
4	Crash function
A	Connection to rear axle differential

F30 Powertrain

8. Shafts

8.1.1. Variants

Model	Transmission	Front connection	Middle connection	Rear connection
BMW 328i	GS6-17BG	GS 96M12	KG48	GS 96M10
BMW 328i	GA8HP45Z	GS 96M12	KG48	GS 96M10
BMW 335i	GS6-45BZ	GS 105M12	KG60	KFG Z34
BMW 335i	GA8HP45Z	GS 105M12	KG48	KFG Z34

8.1.2. Crash function

In the event of a head-on collision, the drive shaft absorbs a portion of the crash energy. The occupant load is thus reduced and the passive safety increased.

The crash function integrated in the front drive shaft pipe has been optimized. The spring force at which the front drive shaft tube selectively deforms has once again been reduced. The torque transfer capability has remained unchanged.

8.2. Rear axle output shafts

The output shafts for the F30 are designed as a full-length shafts and have different overall lengths on account of the rear axle differential being positioned on the left and right sides. The joints to the rear axle differential and on the wheel side are designed as journals and are mounted by connection.

F30 rear drive shaft

8.2.1. Variants

Model	Transmission	Rear axle differential	Output shaft
BMW 328i	GS6-17BG	HAG 188LW	VL2600i
BMW 328i	GA8HP45Z	HAG 188LW	EBJ95
BMW 335i	GS6-45BZ	HAG 215LW	VL3300i
BMW 335i	GA8HP45Z	HAG 188LW	VL2600i

Bayerische Motorenwerke Aktiengesellschaft
Händlerqualifizierung und Training
Röntgenstraße 7
85716 Unterschleißheim, Germany